

## Further research on the electrification of pyrocumulus clouds

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Past research on pyrocumulus electrification has demonstrated that a variety of lightning types can occur, including cloud-to-ground (CG) flashes, sometimes of dominant positive polarity, as well as small intra-cloud (IC) discharges in the upper levels of the pyro-cloud. In Colorado during summer 2012, the first combined polarimetric radar, multi-Doppler radar, and three-dimensional lightning mapping array (LMA) observations of lightning-producing pyrocumulus were obtained. These observations suggested that the National Lightning Detection Network (NLDN) was not sensitive enough to detect the small IC flashes that appear to be the dominant mode of lightning in these clouds. However, after an upgrade to the network in late 2012, the NLDN began detecting some of this pyrocumulus lightning. Multiple pyrocumulus clouds documented by the University of Wisconsin for various fires in 2013 and 2014 (including over the Rim, West Fork Complex, Yarnell Hill, Hardluck, and several other incidents) are examined and reported on here. This study exploits the increased-sensitivity NLDN as well as the new nationwide U.S. network of polarimetric Next-generation Radars (NEXRADs). These observations document the common occurrence of a polarimetric "dirty ice" signature - modest reflectivities (20-40+ dBZ), near-zero differential reflectivity, and reduced correlation coefficient ( $< 0.9$ ) - prior to the production of lightning. This signature is indicative of a mixture of ash and ice particles in the upper levels of the pyro-cloud ( $< -20^{\circ}\text{C}$ ), with the ice interpreted as being necessary for pyro-cloud electrification. Pseudo-Geostationary Lightning Mapper (GLM) data will be produced from the 2012 LMA observations, and the ability of GLM to detect small pyrocumulus ICs will be assessed. The utility of lightning and polarimetric radar for documenting rapid wildfire growth, as well as for documenting pyrocumulus impacts on the composition of the upper troposphere/lower stratosphere (UTLS), will be discussed.